METHOD AND APPARATUS FOR IDENTIFYING FEATURES OF MULTIDIMENSIONAL IMAGE DATA IN HYPERMEDIA SYSTEMS

Field of the Invention

The present invention relates to a method and apparatus for identifying features of multidimensional image data in hypermedia systems.

Background Information

The World Wide Web ("Web" or "Internet") provides a simple mechanism, called an image map or ISMAP, for linking two-dimensional spatial data (e.g., images) to related symbolic information such as Universal Resource Locators (URLs). Image maps are a simple technology that link simple polygonal regions within images, often referred to as hotspots (e.g., a graphically defined area in an image), to the locations of data objects on the Internet via a hyperlink. Web image maps currently are the standard mechanism used for creating graphically attractive user interfaces to Web pages. For example, an image could be made into an image map by assigning hotspots to each region of interest on the image. Unfortunately, the standard polygon-based ISMAP technology used in most Web image map systems can only work with simple polygon maps, and becomes either intolerably slow or

totally unusable for mapping high-resolution images with large numbers of irregularly shaped objects, such as, for example, objects in the medical anatomy image data which comprise the National Library of Medicine's Visible Human Project.

U.S. Patent No. 4,847,604, which is hereby expressly incorporated by reference, describes a method and apparatus to provide additional information concerning a feature of a displayed image by pointing to the location of the feature. The '604 patent provides for the correlation of particular locations in the image with the additional information for two-dimensional images. A need exists to provide such correlation for multidimensional images.

Summary of the Invention

A multi-dimensional object indexing system allows many discrete objects to be mapped within a single multi-dimensional dataset. A secondary spatial image of an original image is correlated using a multi-dimensional coordinate value to provide an object index for each object defined in the original multi-dimensional image.

Brief Description of the Drawings

Figure 1 illustrates a flowchart for a method of identifying features of multidimensional image data according to an exemplary embodiment of the present invention.

Figure 2 illustrates a flowchart for a method of processing multi-dimensional image data according to an exemplary embodiment of the present invention.

Figure 3 illustrates an exemplary system for identifying features of multi-dimensional image data according to an exemplary embodiment of the present invention.

Figure 4 illustrates an exemplary database table according to an exemplary embodiment of the present invention.

Detailed Description of the Invention

Figure 1 illustrates an exemplary flowchart for a method of identifying features of multidimensional image data according to an exemplary embodiment of the present invention. For example, at 1010 an image is accessed, such as a multi-dimensional image or animated GIF image on a web page. At 1020, a location in the image is indicated, for example by clicking on a part of the image using a mouse or other interface device, the image having been preprocessed to be an image map as described, for example, in the '604 Patent or as described below with regard to Figure 2.

At 1030, a multidimensional coordinate location is determined for the location identified at 1020. For example, the image map may be a two-dimensional representation (e.g., x-y) of a three dimensional image, such as a three dimensional medical anatomy image maintained by the National Library of Medicine's Visible Human Project. The two-dimensional representation may reflect a particular third dimension view. For example, a particular slice of the image may be shown to a user thus providing a predetermined third dimension, or z-value, for the representation of the image displayed to the user. Accordingly, selecting a particular location on the representation defines the x and y values for the location and the third dimension is already defined. As a result, the multi-dimensional coordinates of the selected image location can be determined.

In an alternative exemplary embodiment of the present invention, the selection of a image for correlation with additional information may be a multi-step process. For example, an image of an entire anatomical body could be presented to a user and a general area of the image selected, such as the chest, head or abdomen. In response, a detailed view of the related region could be displayed to the user. The user would then select a particular location in the image and receive additional information related to the selected location. As noted above, the images presented to the user will generally be two-dimensional representations viewed on a predetermined or selectable third dimension. In addition, the original image can be manipulated, rotated or sliced for viewing in a preferred orientation. The image location eventually selected by a user, regardless of the orientation and display of the image, will correspond to a particular multi-dimensional coordinate which can be correlated with additional information as described below.

Alternatively, the image map could be a video clip having x and y values for each frame of the video clip and the third dimension, in this case time, would be determined by the particular frame of the video clip. Thus, multi-dimensional values can be determined for an indicated location. The present invention is not limited, however, to three dimensions as four or more dimensions can be processed according to exemplary embodiments of the present invention. For example, a three dimensional image dataset that changes through time would provide for four dimensions (e.g., x, y, z and time).

At 1040 a secondary map is queried for the determined multi-dimensional value where, for example, a given x,y,z coordinate in the original image data corresponds to an homologous x,y,z location in the secondary "map" of, for example, 24-bit voxels

(e.g., three-dimensional pixels). The 24-bit voxel found at that location in the secondary map then acts as a unique 24-bit object index for the image feature in the original data. At 1050, the system then performs a database table lookup for that 24-bit index in order to find the related descriptive text information or "hot data," which may be in the form of, for example, HTML code, a URL pointer to a remote Web resource, or Tcl-based applet code. Using the 24-bit voxel allows as many as 16 million discrete objects to be mapped within a single three-dimensional dataset. If desired, even more objects could be mapped in the dataset by using 32-bit voxels. Using an exemplary embodiment of the present invention, animated GIFs, AVIs and MPEGs can be processed to provide enhanced functionality to a Web page to extend image capabilities to multi-dimensional datasets.

Figure 2 illustrates an exemplary flowchart for a method of processing image data according to an exemplary embodiment of the present invention. At 2010, multi-dimensional image data is imported. The image data can be, for example, a GIF file of an image or a JPEG or MPEG file of images. At 2020, objects in the image data (e.g., hotspots) are, for example, interactively outlined. An exemplary method for outlining the objects is described in the '604 Patent although other conventional approaches known in the art may be used. The outlining of hotspots requires the user be presented, for example, a two dimensional representation of a multi-dimensional image as described above. Thus, additional dimensions can be predefined for the two-dimensional views presented to a user. At 2030, a program action is determined and associated for each object in the image data. For example, the program action can display explanatory text related to the object in the image or provide a link to a particular Web page. As described above, the program

action can be in the form of, for example, HTML code, a URL pointer to a remote Web resource, or Tcl-based applet code.

At 2040, a secondary image map is generated for the image data. The secondary image map provides, for example, a spatial index of the image with equivalent spatial dimensions as the original image. The secondary image map utilizes, for example, unique 24-bit voxels to associate a unique 24-bit identifier with the pixels in an object outlined at 2020. Alternatively, pixels within an object can have different unique identifiers defining, for example, sub-regions in the object having associated program actions. Other object indices could be used instead of the 24-bit voxels, however, such as a list of polygons or some other indice that correlates a coordinate value in the original image with the secondary image map. The 24-bit values are, for example, arbitrarily assigned to groups of pixels or individual pixels in the object.

According to an exemplary embodiment of the present invention, each pixel in the object can be an independently addressable hotspot, including for multi-dimensional images. For example, for each mapped multi-dimensional image on a Web page, the Web server hosting the Web page stores the secondary image map. Each pixel or group of pixels in a hotspot defined for the image corresponds to, for example, a flat area of 24-bit color in the secondary image map, as each object pixel or group of pixels owns a unique 24 bit color in the secondary image map. While the primary (original) image is displayed to the user, the secondary image may is generally not shown to the user, although there may be circumstances in which it is desirable to show the secondary image map. At 2050, object table files are generated to associate the pixels in each object with the program action identified at 2030. The object table can have the form of, for

example, a database lookup table indexed by the 24-bit voxels to find the corresponding program action for each pixel.

Exemplary operation of the method for identifying features in multidimensional image data is as follows and as illustrated in Figure 3. When a user clicks on a location of a multi-dimensional image in an image map in a Web page via a Web browser, the Web browser sends the, for example, x-y coordinates of that location to the Web server. Web browser 3015 can include, for example, conventional Internet browser software such as NETSCAPE® browser software operating in a conventional desktop personal computer 3010, as illustrated in Figure 3. Web browser 3015 transmits the x-y coordinates to Web server 3020 via a communications link 3030, such as a LAN, WAN, fiber optic, wireless or other conventional computer network communications link. Web server 3020 includes, for example, a conventional NT or SUN Microsystems server and processes the x-y coordinates to generate a multi-dimensional coordinate value.

As described above, the third dimension may be predetermined as a function of the image presented to the user such as a particular "slice" of an image or a frame of a video clip. Once the multi-dimensional coordinate value is determined, the Web server 3020 launches a, for example, Java-based CGI program to find the corresponding multi-dimensional coordinate value in the secondary image map to determine the unique 24 bit value corresponding to the pixel clicked on in the image by the user. The CGI program then sends the 24-bit value to a, for example, Tcl-based server which takes the 24-bit value and fetches a record from the database lookup table for the corresponding program action to be taken, or the Web server 3020 itself processes the 24-bit value and uses the value as an index into database 3040 coupled to Web server 3020 to determine the program action to be performed. The

program action is relayed back by the Web server 3020 for display to the user at client computer 3010, usually in a frame next to the image map. The program action can include, for example, browser redirection, encapsulated HTML, dynamic HTML and downloading and running full-frame applets in the user's Web page. Other program actions can be performed as well. Figure 4 illustrates an exemplary database table associating a program action 4020 with each identifier 4010 in the database table, such as each unique 24-bit value.

Thus, according to an embodiment of the present invention, individual pixels or voxels in objects of multi-dimensional image data can be automatically linked to desired program actions in contrast to prior art systems which are limited to indexing of two-dimensional Web images.

The additional dimension added to the indexing of image maps can vary as a function of the type of image data displayed. Thus, for example, the additional dimension could be the z-coordinate for three-dimensional images or the time dimension for video clips or both for three-dimensional image data recorded over time as well as additional dimensions. Like the multi-dimensional image data, the secondary image map according to an exemplary embodiment of the present invention can have n-dimensions. In addition, the individual pixels in an object of a multi-dimensional image can be individually addressable. Moreover, by adding a dimension to a standard image map request protocol in accordance with an exemplary embodiment of the present invention, the display of an image on a client side of computer network can be independent of the server performing the object identification in the image, thus allowing the capabilities provided by the present invention to be implemented using conventional personal

computers or even less powerful devices such as handheld computers or smartphones.

An exemplary implementation of the method according to an embodiment of the present invention is illustrated below and uses a small (30K) Tcl-based client applet which downloads and runs within the user's Web browser page. For example, when a user accesses a web page with multidimensional image data to be viewed, an applet such as the applet described below would be automatically downloaded to the client computer. The applet would then, for example, fetch the appropriate image data, secondary image map and object index table and download the data to the client computer. The client computer web browser then interacts with the download applet to view the image data, for example in the manner described above. For example, the Tcl applet converts the image data back to a viewable image. If the image is a video clip, for example, then the video clip would be displayed to the user. The applet program then waits for the user to click on a location in the video clip. When the user clicks a location, the frame number is determined and the x-y location of the click is determined as described previously, thereby enabling a multidimensional coordinate location for the click to be determined to use as an index into the secondary image map, from which the program action can be determined via an object index table.

Tcl/Tk (v. 8.0) Source code for a zMap client-side applet (requires the Tcl Netscape plug-in v. 2.0 from Sun Microsystems, or equivalent):

```
        #   Eolas Client-side zMap Applet
        #   Copyright (C) 1997, 1998 Eolas Technologies Incorporated.All rights reserved
        #   Distributed only as a part of the Eolas zMap CS v 1.0 package
        #   For more information on Eolas' zMap products, see http://zmap.eolas.com

        policy outside
        package require http
################################################
#   zMap procedures
#
```

```
###################
proc zmap_setup {}  {
       global strip which nFrames delayInterval oldurl zmap_url _url width map \
       clr_map zmap rgb target
       set which 0

       image create photo strip -data $strip
       image create photo clr_map -data $map
       label  zwin.1 -border 0; pack zwin.1
       pack .zwin -anchor w -expand 0 -fill none
       set nFrames [expr [image width strip] / $width]

       for {set i 0} {$i < $nFrames} {incr i} {
          image create photo p$i
          p$i copy strip -from [expr $i * $width] 0 [expr ($i + 1) * $width] 50
       }
       set which 0
3 set up binding for imagemap query as a result of user's mouse click
              bind zwin.1 <Button-1> {

                     set zmap_x [expr ($which * $width) + %x]
                     set zmap_rgb [clr_map get $zmap_x %y]
                     set rgb_list [split $zmap_rgb]
                     ::browser::displayURL [querytcl [lindex $rgb list 0]\
                            [lindex $rgb_list 1] [lindex $rgb_list 2]] $target
                     }
              bind zwin.1 <Button-3> {
                       ::browser::displayURL http://www.eolas.com/metamap $target
                     }
}
###################
proc zmap_playnext {}  {
       global  nFrames which delayInterval

          if {$delayInterval != 4000}  {
            incr which
            if {$which >= $nFrames}  {set which 0}
            .zwin.1 configure -image p$which
          }
          after $delayInterval zmap_playnext

}
###################
proc querytcl {R G B}  {

global header ztable

set id [array startsearch ztable]

if {[string length $R] == 2}  {
       set R O$R
       } elseif {[string length $R] == 1}
       set R 00$R
       }

If {[string length $G] == 2}  {
       set G O$G
       } elseif { [string length $G] == 1}  {
       set G 00$G
       }

if {[string length $B] == 2}  {
       set B 0$B
       } elseif { [string length $B1 ==1}  {
```

```
        set B 00$b
        }

set searchfor $R$G$B

        while {[array anymore ztable $id] != 0}  {
             set colors [array nextelement ztable $id]

             if {$colors == $searchfor} {
               set record [array get ztable $colors]
               set record [lindex $record 1]
               set flag [lindex $record 2]
               set script [lindex $record 3]

               switch [string trim $flag] {
                 html { return "$header(html)$script" }
                      url { return "$script" }
                      default { return "$header(html)Incorrect flag in \ database" }
                 }
               array donesearch ztable $id
               break
             }
        }
}
###################
proc assign_strip_url {token}  {

global url_data state strip go

        upvar #0 $token state
        set url_data $state(body)
        set strip $url-data

if {$go < 3}  {
        incr go
        } else {
        zmap_setup
        zmap playnext
        }
}

proc assign_map_url {token}  {

global url_data state map go

        upvar #0 $token state
         set url_data $state(body)
         set map $url_data

if {$go < 3}  {
         incr go
         } else {
         zmap setup
         zmap_playnext
         }
}

proc assign_table_url {token}  {

global url_data state table go ztable

        upvar #0 $token state
         set url_data $state(body)
         set table $url data
```

```
        array set ztable $table

if {$go < 3} {
        incr go
} else {
        zmap_setup
        zmap_playnext
        }
}

# end proc definitions

###################
# begin code main body
########
global ztable width delayInterval header map clr_map zmap_rgb url_data strip \
state table go target
set width $embed_args(frame_width)
set map_image $embed_args(map_image)
set anim_image $embed_args(anim-image)
set dfile $embed args(dfile)
set target $embed args(target)
set rate $embed-args(rate)
set delayInterval $rate
set header(htm-1) "Content-type: text/html\n\n"
set header(url) "Location: "
# Fetch the image, map and object-table data
      ::http::geturl $anim_image -command assign - strip_url
      ::http::geturl $map_image  -command assign_map_url
      ::http::geturl $dfile      -command assign_table_url

set Name.zwin
frame $Name  -background LightGray -border 0 -relief flat

scale zwin.scale -from 1 -to 4000 -orient horizontal -width 8 -sliderlength 8 \
    -tickinterval 0 -length $width -variable delayInterval -showvalue 0 -borderwidth 0
\
    -troughcolor black -border 0
pack.zwin.scale -side bottom

set go 1

######
end of applet source code
###################
```

An exemplary object index, image and secondary image map are illustrated below.

Object information table for the above *z*Map client-side applet demo:

(filename: world.mtb)

189129190 {south_america_too {{}} url south_america.htm} 251000251 {carribean_islands {{}} url caribbean.htm} 185255185 {ireland {{}} url ireland.htm} 255196255 {australia {{}} url australia.htm} 078173214 {cook_island {{}} url pacific_rim.htm} 155155155 {south_america {{}} url south_america.htm} 255255081 {indian_ocean {{}} url indian_ocean.htm} 000189000 {africa {{}} url africa.htm} 102102255 {japan {{}} url japan.htm} 000128000 {hawaii {{}} url hawaii.htm} 255198140 {europe {{}} url europe.htm} 255183219 {bermuda {{}} url bermuda.htm} 189185219 {iceland {{}} url iceland.htm} 255000000 {atlantic_ocean {{}} url atlantic.htm} 255196225 {australia {{}} url australia.htm} 255185220 {asia {{}} url asia.htm} 128000128 {indonesia {{}} url indonesia.htm} 255128000 {pacific_ocean {{}} url pacific_rim.htm} 230204255 {new_guinea {{}} url newguinea.htm} 255077166 {arctic_ocean {{}} url arctic.htm} 189189255 {mediterranean_sea {{}} url mediterranean.htm} 064128128 {north_america {{}} url north_america.htm} 000255255 {bering_sea {{}} url pacific_rim.htm} 255255000 {new_zealand {{}} url newzealand.htm} 64128128 {north_america {{}} url north_america.htm} 064149200 {greenland {{}} url greenland.htm} 255255255 {space {{}} url space.htm} 000185000 {madagascar {{}} url africa.htm} 148148148 {indonesian_islands {{}} url indonesian_isles.htm}

Animation image strip for the zMap applet demo (Base64-encoded GIF image):

(filename: world.man)

R0lGODdh3AUyAKUAAAAAAAAAAbQAAmAAA7gAAhAAAxgAAsgAAigAAtQAASwAAoQAAzAAA9wDv
AAAA+gDXAAAA5gAAfADNAADHAADBAAAA/QC5AACvAAClAACZAACLAAAAwQAFIgAA7AB7AAAA
rQAA2ABTAAA1AAAA8gAAiAAA3gAAtgAAkQAAEwAAvwAA1gAAlwD8AAD2AAAAbwDoAADgAAAA
yAAA8wAAYQAA4gAAeAAAowBoAAAApgAAPAAA0QAA/AAAUwAA6AAAAAAAACwAAAAA3AUyAAAG
/kCAcEgsGlHIJMrIbDqfRCV0Sn0mq9isEKntaq/e8HbIFZu31+W5Ky2vvWr1Gx6f08H2Lz5f
Vbr5UH5ygIF+hFSCh10JilaGjU5lg5BHS3+UlZ0YRZebnGOeTXuhAFKkUaanjKqPrKmhgpqN
KCIcOTkJubkivCKQSBy2uLohvMGydkvBt7oJxTkcvrMowSLDuSE5tSLIc8DCzQm3wb/U4M3j
0orfzOjQHL8AvSLh4/CU8/Xv5b3XuemUqFmj544cpWoEddnr5q2aP3H7Dp5TCE3dIXYPAUps
RzFawGUZK2ICWa9XOZLueH2c+E/kL5QdLV6E2bLWSJYQDUKimZMD/sM5PK3pbMTTHiZeHFse
w4dz4caHve7Nolms108zvBLwmME1gFevM26E4CF0ah5rWrn0+AqWK49sMueg3dqVrVqyKgHN
Vcs2ANcQgLUR2lv3690EefNQw0V3rV23i0OuWaw1ROG2M/BKXmMr7WW/kBMn69y472HRdngB
5vs4c1lAtEQAtuzYcGizdmzNvlEbs2bYnQHzNu22KqFonnuDdo0aKC7hyu8aB4T87fDWgJu/
UV0a+3Q+hKOH3nwmPPHM35OZb/2bD+XutpmTx8qYtWHeZAXrrf/59Hwx68WXH25y0QOfb+L8
F0aAXt0g1oCDGWhfg2IFRuB2En7m4Gw2/ukl24EBbJjdhWtwN2GIDyYInmw3h0hCDTBGICOM
NbgAVjYkeqGagwG8GOOMMNrIG46picBDiz3SKGMENAopVocYbuWVjzUs2eSN2sHBi5RJ/shk
kFgqiMWWjlFpJZghpmfGYlyaCWSNDaopBptlKvmmjX7xA0UZtOTA5Q12fgmnX3A15GeZHnh5
JaF7rrnjlIEu+mSOX0QTgoM3uCkonpOmls0lmEbqgQctbpglG9FshemoVd6JqZwAGrmWg6ye
WeOrp3axJZI3j0qBrU7CuuCndY4KbJy5aqHarL0mCmypwrKx65S+/spkonjOEK2usqII46+/
fpvttlkIZBmk/j+yOqi2yWKx2LldtqruuO32QSa6rUbAarZ6Uqpst/HKWC2SmekXZZ3p1jAq
jwX7m8Wy+C7pK6Y38ABNkZdGLPDCr15cILyaKuzBuB5jmHHAQI4MlsUOj8mixl+SiiKRJbLY
bAQEEEACCQf0vDMBvrrgoJ5iPrHjzTnv3PMBPxNw7YYlh2Eprb7qzLPPJOT89JNFO3F0tRoo
jbXWCpvadROPuvBr0lcznbXTZXO95tRJ4qyzBks3vTW5U6RdpQdW4+022ULSHAabDr5ot9J4
6x03y3MfWjfbPYf99taQz6nbWopTPrbTHBsOhy1Sdm513iRoAHTcxbT8RKphmS62/tsaDCyW
wcMe2WuVng9ue+vlSV5t4J9PLLcZurWo9qiWH9B46nCTenysqr7IfNiV/wyu9HxD8aizHmgg
/tJhE262oy93Lv74g8Mt9PRa2qy2vgSs/zzhadYbydRIh22/49zTnyiONj/A2U9817sV/FAl
v78F7oDuy9/ZjkC62PGufgoUX7hspC3cSctIyrtg6jK4rzxF7YMZkx3P7Ac0X4Uoc7EC1Qqz
pzrQkapgEzQCAUXYtp2pjknvg+GCb0as3ultVIQ6IbdAVcTT+Ux8qxOSEHVERB6ijmw3nKKy
mMg8561gBQIIYxi/eALnTSwzORwCEa93gi+KcYwrKCMJ/sBlKgBxMXzic+MbyWjG0KVRCGvE
owYyAEYBZACOZaydH+1INQwOspBi50McF7mgO+JtkBk4ZCTjyDS4DS0HANKdwnTmxUzukZOK
rIEJD/epFo3qbm0EYyYP+cX1ubBgrJSSr3h2AkKGcZaZPIEGF4ZL0Ei0d7zU4y8zaUu0WSyX
a0HmAWJpSDEyc5jSe6YxpSRNau4xA83MJijD4KcWdV0ZcAxnHRekql10E52GXIE6nyQGYgVA
ZOLz5iYTabxihHItalufL08px37+UR7nEtkKZ01QphmUkb3CGd56yVBEQpGS0rKkBmIJTAHw
sXb6WicbWtksD6zQjcCUpAvp/rnNRk5UjymVI+hE+gWS7nKjA10mODvJJJqWq5wlPaksrQnO
8jEpT39EgfBGlcxCmrKWUNQXUg8HwojW751DRaQZj1pML9gUcE19o0d3mjUkdlVXdwzrKW3Z
07NukWomxeobCZmBRLZwlZWE60sh0caigrQG+BmnjjSqz3T20Q0MyquvxDdLDNgAB5CFLAYw

MEtssvSti8VkBiYbWQzgwAaUvebE/InWkjI2k5P1bGRtoIDKKpJUpMXs9RqbWs6yVgEetWxs
H3apzNK2tqmdZR1HZSNtyhaPvwVuaHcKugAYl7emlaxygyvaCBRXsFn4VAB8KwAFTHeyrgXa
dUd6/iRw5bG73p2ua3813pryoEf60q0CvIsDz9Z2vSOrGHb74Cf4EmCaslTAYyVL3aK68Ln8
fa8LcPbO7jo2spAFLX5hu98q9HfB9Wsjege82uXqNo0XZrCG58vhCLdWtAvb7ZgutWA8gpHE
EP7sfFEM2xzSorwMlqyAY4yBGRs4xWmUDXw98E7Uqna1J/5xjQcbUSIP0sGpRfKEL+suFmV2
BRmYL3BljFslU5m/vZltlh9c29t6VJgt/DIi+uvbMR+5trjlJHHVvAg2M6+XU0ZsfcGb2wPM
VMVrLq+YNwvaKIM2k3H8YXFtfOFBp5fAPe5yGZ22aPL6V74C5qx9KZtb/kU7t8JU004rcZrJ
He+5vvM15KSt+2kdKfh6snxwZ3tMSzSzGsFVsLKYYQxh0J4Yb3fFNRV0jdxSl1jG4Q2pnrwa
5mJnmcOePTSKbQToKXDxtJO9gLa1bQADbPsC4P3xhrRwbUxm+9vbNsAHwB3aYY47C+U2MrrR
/YFwulss5KYatjEwb3Qju3yqxDe89Wlufvd725PF7QnmqMoZJCDfzdr3wRHO6YUToOEPH3jE
Cz5xbfMZ4H7JOBbivVkMrHvi4UYzxstlmV5hUN4dt3dZQ16uBDhIYaT2bMfZfc2L09xdCYjm
3TIJ2nV7u9/2VuTP+xD0e+rsBN0F7c6TzjGR/leh6TV4etRxcPJ0f5vq3G050EkA9Qw89gMf
OLrXeS5ugY/851rPNNq7rXaKo3hI5A4LUyl69rTTve71vbvbqwAqnEM9vRfw+9+PDnYHWZ0K
TLybIR+b7sWj3bGCDwHL9X14nXf972j/7CHvrXmgExy1XL9Atysf+kNf9N1MB2j4KDrZuate
7ZdnrQAsDtjBLwLrxT737YefeBnvPmu9L33st/vykqN79eoGt+55v6GrkAH4+/48t739gcAf
3+faqvnYOX7w3Csc+UtHBNbjLvx+d98Gh+R9+qnQdAMeXuoxdz36HZ7ve5q04GiHchWnSLzx
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Secondary-map image data for the zMap demo applet (Base64-encoded GIF image):
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cLAICAAAOw==

An alternative exemplary implementation according to an embodiment of the present invention could use a small (30K) Tcl-based client applet similar to that described above which downloads and runs within the user's Web browser page but where the image data is not downloaded to the client computer but instead is remotely manipulated by the user. For example, the image data could be too large to download to the user. Such an applet would, for example, open a socket communications channel to a remote visualization server that stores and manipulates three dimensional image data. When the user makes a change to the controls in the applet GUI, such as to specify rotation around an axis, the remote visualization server would perform that computation on the data and transfers the resultant data display back to the user for viewing the result of the manipulation within the display frame of the client applet. The user could, for example, slice through the data at any angle and click upon any voxel on any slice surface to cause the associated descriptive text to be shown in the lower widow of the applet, for example in the manner described above. The efficiency of this type of system is such that object identification and response occurs in nearly "real time" with identification speeds of, for example, approximately ½ second over 56KB Internet connections.